

New records of the Pampas Cat, *Leopardus colocola* (Molina, 1782) (Mammalia, Carnivora, Felidae), from the Chaco ecoregion raise questions about its status in Argentina

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Abstract

Leopardus colocola (Molina, 1782) is a poorly known small felid distributed throughout a large portion of South America, reported as extinct in the Pampas of Argentina, and absent from a large portion of the Argentine Dry Chaco. We compile data from the field and national collections to report new occurrence records of this species from the Dry Chaco of Argentina and update its distribution. We discuss the need of further assessments of the distribution of this species in the light of ongoing land-use changes in the area.

Keywords

Conservation, Dry Chaco, Gato del Pajonal, land-cover change, medium-sized to large mammals, silvopastoral systems.

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Introduction

The current conservation status of many of the world's mammals is precarious, mostly due to threats such as over-exploitation and habitat loss. In fact, at least one-fifth of the world's mammal species are at risk of extinction (Hoffman et al. 2011), and more than 70% of the

endangered species have experienced population decline since 1990 (Ceballos et al. 2017). In Argentina, more than a quarter of mammal species are listed under some conservation category (SAyDS–SAREM 2019). Accurate delimitation of species' distributions are key to

anticipating the threats to species, and this knowledge is of high practical importance to decision makers (Villero et al. 2017).

The Pampas Cat, *Leopardus colocola* (Molina, 1782), popularly named after a grassland biome that occurs in Argentina, Brazil, Paraguay, and Uruguay, is a poorly known, small felid distributed throughout a large portion of South America. Although information on population numbers for this species is limited, the knowledge to date suggests that this species is rare and has low population densities throughout most of its wide range. Its range includes the Andean mountain chain from Argentina and Chile through Peru, Ecuador, and possibly marginally into southwestern Colombia; the Patagonia, Monte, Espinal, Yungas, and Mesopotamia regions in Argentina; the Pampas and Pantanal in Brazil; and the dry forests of Bolivia (Silveira 1995; Nowell and Jackson 1996; Dotta et al. 2007; Ruiz-Garcia et al. 2013; Lucherini et al. 2016). It is considered extinct in the Pampas of central Argentina (Pereira et al. 2002), and some unpublished data recorded this species in the Cerrado and Atlantic Forest biomes of Paraguay (Giordano et al. unpublished data).

The taxonomy of the Pampas Cat is complex and still unresolved, but the morphological, genetic, and ecological evidence indicate clear differences among regional subpopulations. García-Perea (1994) proposed a complex of three species and 11 subspecies based on morphologic evidence. Later, Johnson et al. (1999) recognized one species and three genetic groups; Wozencraft (2005) recognized three species and nine subspecies; Nascimiento (2010) considered six species; Kitchener et al. (2017) recognized one species and seven subspecies; and Da Silva Santos et al. (2018) recognized five genetic groups. Recently, Nascimiento et al. (2020) identified five monotypic species based on multiple lines of evidence derived from morphology, molecular, biogeography, and climatic niche datasets.

The Pampas Cat is globally categorized as Near Threatened by the International Union for Conservation of Nature (IUCN) Red List (Lucherini et al. 2016) and as Vulnerable in Argentina (Lucherini et al. 2019) largely due to habitat loss, but additional threats such as predation by dogs, hunting, and road kills are also causing populations to decline (Lucherini et al. 2016). While a portion of the species' distribution range overlaps with the Gran Chaco, previous records from the Argentine Chaco have been restricted to the western Dry Chaco, either originating from the ecotonal belt adjacent to the Monte ecoregion, or from the transition forests near the Yungas (Pereira et al. 2002; Lucherini et al. 2016). This absence of records from large portions of the Argentine Chaco is striking, as the most suitable habitats for the species include open and dry areas, including shrublands, herbaceous steppes, and low xerophytic forests (Nowell and Jackson 1996; Pereira et al. 2002).

It is possible that such lack of records is at least partially due to the lack of specific assessments targeting the

species in that ecoregion. Meanwhile, the most suitable environments for this species are disappearing rapidly across the Argentine Chaco as it undergoes accelerated changes in land-cover, mostly due to the expansion of croplands and pastureland. These land-use changes have already led to the loss of more than 25% of the natural habitats in the Chaco (Vallejos et al. 2015; Piquer-Rodriguez et al. 2015; Baumann et al. 2016). Although empirical evidence for the consequences of these habitat modifications on the ecology of the Pampas Cat is lacking, these actions may cause further declines in regional populations (Lucherini et al. 2016).

Here, we report new occurrence records of the Pampas Cat, *L. colocola*, from the southern and central Dry Chaco of Argentina, updating the distribution of this felid in the region. We also discuss the need of further assessments for the species' distribution in the light of ongoing land-use changes in the area.

Methods

Our study focuses on the Argentine Dry Chaco, a sedimentary plain extending from the northern border of Argentina, south to San Luis and Córdoba provinces (Fig. 1). The climate in the Dry Chaco is highly seasonal, and natural vegetation consists of arid woodlands interspersed with shrublands, grasslands and savannas (Torrella and Adámoli 2005). In the past few decades, many natural areas have been converted into farmlands, and the landscape is now a fragmented mixture of natural forest, cropland, and pastureland (Hoyos et al. 2012; Baumann et al. 2016).

The region is characterized by high levels of endemism [e.g. Chacoan peccary, *Catagonus wagneri* (Rusconi, 1930)] and species diversity (Torres et al. 2018). It includes more than 25 species of medium-sized to large mammals, many of which are under threat and severely affected by traditional and recent land-use changes occurring throughout the region (Periago et al. 2015; Romero-Muñoz et al. 2018, 2020). The top predators of the regional carnivore community are Puma, *Puma concolor* (Linnaeus, 1771), and Jaguar, *Panthera onca* (Linnaeus, 1758), although the latter is considered ecologically extinct in the Argentine Chaco (Quiroga et al. 2014). Small and medium-sized cats include Geoffroy's Cat, *Leopardus geoffroyi* (d'Orbigny & Gervais, 1844), Jaguarundi, *Herpailurus yagouaroundi* (Geoffroy Saint-Hilaire, 1803), and Ocelot, *Leopardus pardalis* (Linnaeus, 1758) (Perovic and Pereira 2006).

Our findings are the result of two separate field research projects targeting medium-sized to large mammals in the Argentine Dry Chaco. Additionally, we report records derived from a national assessment of the Pampas Cat distribution in Argentina, which encompasses the entire country.

One of the field projects was based in the northern portion of this ecoregion and includes the provinces of Salta, Santiago del Estero, Tucumán, and Catamarca,

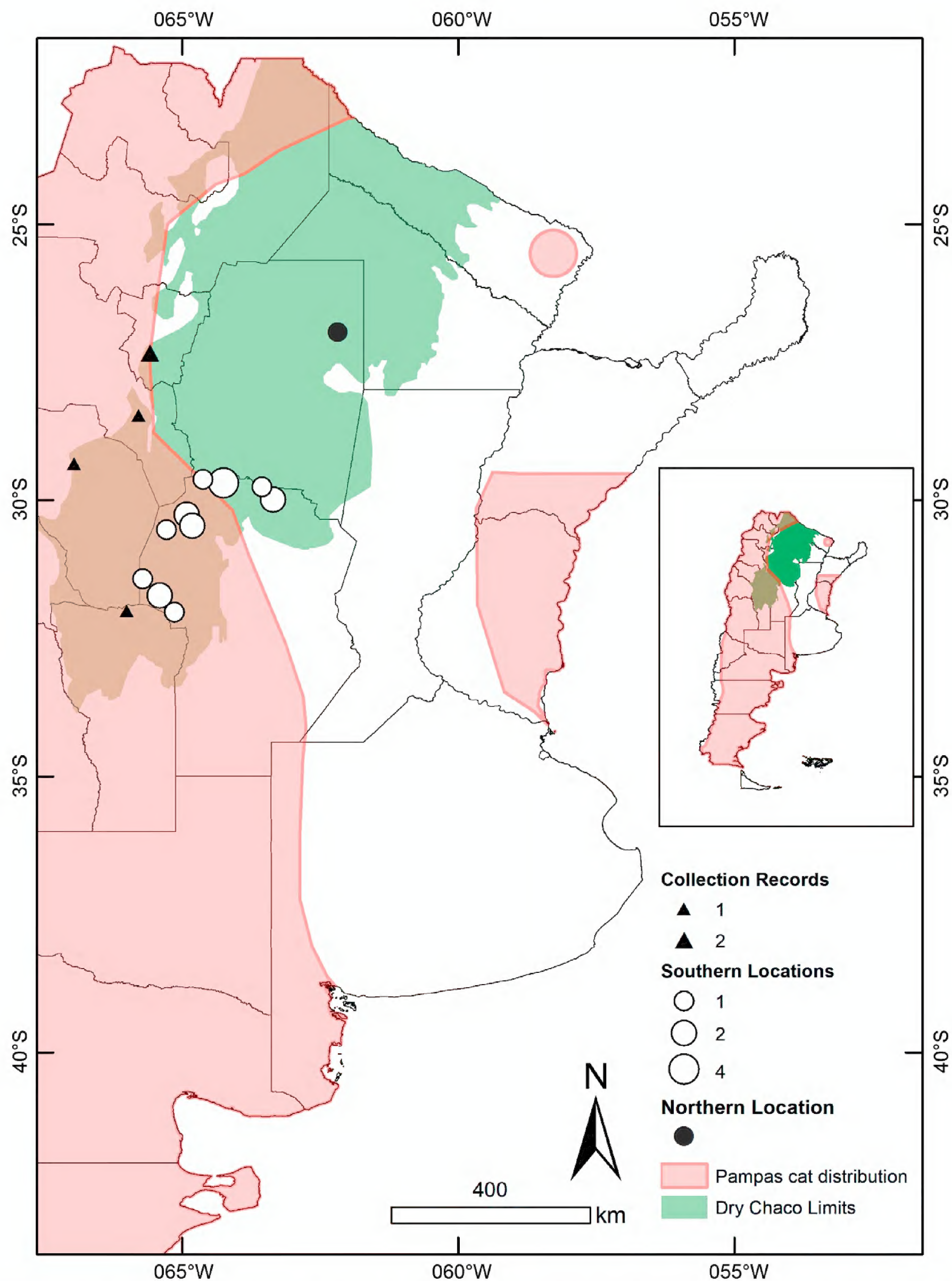


Figure 1. Map showing the Pampas Cat distribution range in Argentina according to the most recent species assessment of the IUCN Red list (Lucherini et al. 2016); the limits of the Argentine Dry Chaco ecoregion; and the locations of the new presence records reported in this study. The triangular symbol represents the records obtained from the national collections, which are not reported as new due to their collection date on specimen labels. The size of the symbols differentiate the number of specimens observed on each locality.

and the second field project has focused on the southern portion of the region, specifically Córdoba province. In the northern Dry Chaco, camera-trap sampling was completed in six agroecosystem sites (defined as 300–500 km² areas, in which agriculture and/or pasture and

silvopastoral lands were the main land-cover) between 2018 and 2019. For each study site, 20–30 camera stations operated in the field for 20–50 days in a grid design at a reciprocal distance of 3–5 km, totaling approximately 3000 camera trap days. Because the presence of

the Pampas Cat was not known for this area, we shared the six obtained photographs with eight additional experts to verify that our record corresponded to *Leopardus colocola*.

The southern Chaco research project included 25 sampling sites, with a less intensive sampling effort per site than in the northern area. At each study site, 10 camera stations separated by 1.5 km were deployed, encompassing different land-covers: primary forest, secondary forest, shrubland, silvopastoral farms (i.e., cattle ranching systems with selective logging), and croplands. Camera traps were active in this region for at least 30 days, averaging approximately 300 camera trap days per site and 7500 camera trap days in total.

The material of five national collections of Argentina was examined: Instituto Miguel Lillo (Tucumán), Museo Argentino de Ciencias Naturales ‘Bernardino Rivadavia’ (Buenos Aires), Colección Félix de Azara (Buenos Aires), and the collection of the Mammal Behavioral Ecology Group (Bahía Blanca). Additional distribution records were obtained from the literature, the database of Andean Cat Alliance, and also from the unpublished records of the Biodiversity Information System of Argentina National Parks Administration. If geographic coordinates were not provided, then records were georeferenced according to the Argentine National Geographic Institute. Finally, we developed a map showing the obtained records of the Pampas Cat within the limits of the Dry Chaco ecoregion, overlapped with the proposed distribution of the Pampas Cat in Argentina derived from the IUCN Red List global assessment (Lucherini et al. 2016). Although a national mammal distribution map from the 2019 national categorization of mammals in Argentina is available (SAyDS-SAREM 2019), for the purposes of this analysis, we used the distribution proposed in the global assessment due to its applicability and relevance at a wider scale.

Results

Among the two field projects and the national distribution assessment for the species, *Leopardus colocola* (Molina, 1782) was recorded 18 times from 11 sites within the limits of the Dry Chaco (Fig. 1; see New records). Eleven of those records occurred in the southern Chaco, and most were located relatively close to the previously known local distributional limits for the species (Lucherini et al. 2016; Fig. 1).

An additional photographic record was obtained from a site in the central-east Dry Chaco, approximately 300 km east and 300 km north of the proposed local distribution of the species (Fig. 1). This individual cat was photographed in a silvopastoral farm on the edge of a forest patch and a pasture field, and although the area around this site is heavily deforested, this farm still has relatively large forest patches.

The southern Chaco records included all five sampled land-covers: primary forests (2 sites); secondary forests

(2); croplands (2); scrublands (2); and silvopastures (4). Additionally, five records from the national assessment of Pampas Cat distribution were within the limits of the Argentine Dry Chaco (Fig. 2), but we could not consider them as new. Three of these records do not have the date information, and the other two were collected in 1905, a period when the species probably had a wider distribution in the region.

New records. ARGENTINA • 1; Santiago del Estero, Quimilí; 26°57'20"S, 062°11'70"W; 9 Jul. 2019 at 03.39 am; A.S. Nanni and J.L. Tisone leg. • 1; Córdoba, Villa Dolores; 32°01'33"S, 065°08'30"W; 26 Mar. 2018 at 03.58 pm; L. Castro, G. Boaglio, F. Molina and F.R. Barri leg. • 2; Córdoba, Villa Dolores; 31°43'20"S; 065°24'32"W; 3 and 7 Jun. 2018 at 03.54 and 04.15 pm; L. Castro, G. Boaglio, F. Molina and F.R. Barri leg. • 1; Córdoba, Villa Dolores; 31°25'30"S; 065°42'40"W; 30 Jun. 2016 at 13.50 am; L. Castro, G. Boaglio, F. Molina and F.R. Barri leg. • 1; Córdoba, Cachiyuyo; 30°52'80"S; 065°28'18"W; 22 Sep. 2016 at 00.30; L. Castro, G. Boaglio, F. Molina and F.R. Barri leg. • 1; Córdoba, El Tuscal; 29°37'28"S; 064°37'28"W; 11 Nov. 2016 at 00.40; L. Castro, G. Boaglio, F. Molina and F.R. Barri leg. • 2; Córdoba, Cruz del Eje; 30°27'50"S; 064°49'00"W; 16–17 Aug. 2017 at 10.48 am and 06.40 pm; L. Castro, G. Boaglio, V. Lassaga and F.R. Barri leg. • 2; Córdoba, Cruz del Eje; 30°15'50"S; 064°54'55"W; 27 May and 10 June 2017 at 03.35 am and 09.23 am; L. Castro, G. Boaglio, V. Lassaga and F.R. Barri leg. • 2; Córdoba, Cañada; 29°59'60"S; 063°21'20"W; 08 Jul. 2018 and 31 Jul. 2018 at 03.44 am and 02.04 pm; L. Castro, G. Boaglio, F. Molina and F.R. Barri leg. • 1; Córdoba, Gutenberg; 29°45'20"S; 63°33'10"W; 1 Jul. 2017 at 08.29 pm.; L. Castro, G. Boaglio, F. Molina and F.R. Barri leg. • 4; Córdoba, Loma Blanca; 29°41'20"S; 064°17'00"W; 17 and 25 Apr. and 27 May 2017, at 11.41 am, 18.42 pm, 21.09 pm and 10.35 am; L. Castro, G. Boaglio, V. Lassaga and F.R. Barri leg.

Identification. Species identification was based on the knowledge of the authors and their familiarity with fauna across the region. The main characters that helped us and the experts identify the species as a Pampas Cat are the indistinct markings on the flanks, the transverse dark stripes in the proximal portion of the legs, the comparatively short tail, and the pointed ears, in addition to its overall appearance (Nascimento et al. 2020).

Discussion

Our records extend the distribution of *Leopardus colocola* in Argentina, particularly with respect to what was previously known in the Chaco ecoregion. They also raise new questions regarding its potential population status in the Argentine Dry Chaco, and the response of the species to land-use changes across the region.

The southern records are within the limits of the Pampas Cat distribution proposed by both the global



Figure 2. Northernmost Pampas Cat record and its location in Argentina.

distribution map (Lucherini et al. 2016) and the national distribution map (Lucherini et al. 2019). The northern record, however, is much more unexpected based on the known distribution. The dispersal behavior of small cats is poorly known, but the maximum dispersal distances found for another South American small cat, Geoffroy's Cat, is 128 km (Pereira 2009). Our northern record is 300 km away from the closest limit of the previously known distribution of *L. colocola* (Fig. 1) and so the dispersion from other areas seems unlikely. It cannot be excluded, however, that the apparent absence of the species from most of the ecoregion is due to poor previous sampling in suitable habitats for the species. In the Argentine Chaco, natural open areas are highly threatened by agriculture expansion, while receiving much less attention compared to forests (Grau et al. 2015).

Consistent with the Pampas Cat's preference for open and dry areas, and low xerophytic forests (Nowell and Jackson 1996; Pereira et al. 2002), our records occurred mainly in scrublands, primary and secondary forests, and silvopastoral systems. The latter are relatively novel land-systems in the Argentine Dry Chaco and consist of integrated trees and forage for livestock. The relatively high number of records found in these systems (five of 18) suggests that they may comprise more suitable habitat for this species compared to other land-uses such as croplands. In the case of small and medium sized carnivores, some studies have concluded that finer-scale vegetation structure and characteristics may be better determinants for explaining habitat use than coarse-scale habitat categories (e.g., forest, cropland; Moreira-Arce et al. 2016). Silvopastoral systems are structurally more diverse than monocultures (e.g., pastures and croplands; Ferreira et al. 2018) and, therefore, may provide increased cover and prey availability (e.g., rodents) for Pampas Cats. Because of the selective logging that occurs in silvopastoral systems, they are also more open than primary and secondary forests, which is consistent with habitat preferences

of this species (Nowell and Jackson 1996).

We should stress that the most widespread land-use in the Argentine Chaco is intensive agriculture (Baumann et al. 2016), and very few prior records of the species originate from croplands (Pereira et al. 2002). Therefore, the conversion of natural areas to croplands might pose a threat to this regional population of Pampas Cats. This would be a strikingly parallel situation to that which occurred in the Pampas biome, where habitat modifications decades ago likely led to the local extinction of the species (Pereira et al. 2002).

Although survey efforts are increasing and more projects are targeting this felid in Argentina (Lucherini et al. 2018), the Pampas Cat still remains poorly understood, and additional studies are needed to reliably assess its conservation status both in Argentina and across its range (Brodie 2009; Lucherini et al. 2019). Taxonomic studies are also required to clarify the species and subspecies present in Argentina and the Gran Chaco, as a guide for conservation efforts. In that sense, the new taxonomic revision of the Pampas Cat indicates that four species would be present in Argentina, of which the species inhabiting the Chaco would correspond to *Leopardus pajeros* (Desmarest, 1816) (Nascimento et al. 2020).

The Gran Chaco is very heterogeneous and needs greater survey attention to resolve the distribution of mammals that occur there: some carnivore species for example, while occupying certain parts of the Chaco, appear absent from other portions (e.g., Cartes et al. 2013; Giordano et al. 2018). Because of the small number of records from the Dry Chaco, the Pampas Cat should be considered very rare there at this time, which is also consistent with the reported rarity of this cat for most of its range (Lucherini et al. 2016).

Our findings suggest that greater survey and research efforts should be devoted to confirm whether the Pampas Cat is more common in the southern Argentine Dry Chaco, where most of the records presented here

occurred, and the preferred habitats by this species. It is also key to address the influence of ongoing land-use changes across the region, including the potential importance of silvopastoral systems as more suitable habitat to local Pampas Cat populations.

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Authors' Contributions

ASN and ML carried out sampling in the northern Chaco sites, conceived the research question and led the study. FB and LC carried out sampling in the southern Chaco sites. GAEC compiled the records derived from a national assessment of the Pampas Cat distribution in Argentina. ASN, ML, FB, LC and GAEC collected and analyzed the data. All authors wrote the manuscript.

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